PROC. ENTOMOL. SOC. WASH.
86(3), 1984, pp. 608–613

HABITATS, DISTRIBUTIONAL RECORDS, SEASONAL ACTIVITY, ABUNDANCE, AND SEX RATIOS OF BOREIDAE AND MEROPEIDAE (MECOPTERA) COLLECTED IN NEW ENGLAND

Chris T. Maier

Department of Entomology, The Connecticut Agricultural Experiment Station, 123 Huntington Street, New Haven, Connecticut 06504-1106.

Abstract.—Descriptions of habitats, new distributional records, seasonal activity, abundance, and sex ratios are given for adults of *Boreus brumalis* Fitch and *B. nivoriundus* Fitch from Connecticut and Vermont and for adults of *Merope tuber* Newman from Connecticut. Sticky traps and Malaise traps were highly effective in capturing boreids and meropeids, respectively. Based on trapping in Connecticut, adults of *Boreus* spp. were active from November–April, and those of *M. tuber* were flying from June–October. Systematic sampling with a Malaise trap indicated that the abundance (or activity) of *M. tuber* fluctuated annually and monthly. The mecopteran sex ratios derived from collections were biased in all 3 species. There was a preponderance of males of *B. brumalis* and *B. nivoriundus* in collections from moss and of females in collections from the snow surface. Females of *M. tuber* outnumbered males in Malaise traps and represented the majority of the individuals captured between August and October.

The boreids *Boreus brumalis* Fitch and *B. nivoriundus* Fitch and the meropeid *Merope tuber* Newman are intriguing because their biology is not well known. In New England, these species are poorly represented in most insect collections even though their woodland habitats abound. The scarcity of boreid adults in collections can be attributed to their unusual winter activity and to a lesser extent to their small size and brachyptery. Unlike the predaceous adults of bittacids and panorpids, they consume mosses (e.g., Byers and Thornhill, 1983). The few records of *M. tuber* from New England reflect entomologists' ignorance of its biology. Both the feeding habits and the immature stages await discovery. Distributional records summarized by Byers (1973) indicate the nocturnal adults of *M. tuber* tend to inhabit forests associated with a permanent stream or other water source. Recently, Sanborne (1982), Scarbrough (1980), and Thornhill and Johnson (1974) have reported large collections made with Malaise traps. Sanborne (1982) used live specimens obtained in a Malaise trap to describe the stridulatory behavior of adults.

My principal objectives in this paper are to provide additional records of boreid and meropeid adults from New England and to demonstrate that these insects can be collected abundantly with specialized collecting equipment. The life history and the host plants of the 2 boreids will be presented in detail in a forthcoming paper.

Materials and Methods

Boreid adults were collected by aspirating them from moss and snow and by trapping them on horizontal sticky plates on moss. Sticky traps, which were constructed of 2 × 12-cm pieces of tempered hardboard, were coated on the upper surface with Tack Trap®. To determine the period of seasonal activity of boreid adults, sticky traps were placed on various mosses in forests in Connecticut and were then checked weekly from September–May. In all, 25 sticky traps were used at Cockaponset St. Forest (Middlesex Co.) during 1979–1980, and 45 were used at Sleeping Giant St. Park (New Haven Co.) during 1980–1981 and at West Rock Park (New Haven Co.) during 1981–1982. The mean number per trap per day was calculated for the period from the first to the last capture of each species. This abundance measure was also calculated for another set of 25 traps at the above 3 sites and for 25 traps at Sharon (Litchfield Co.). These four sets of traps were monitored during two 1–3 week periods, one between December 1979 and January 1980 and one between March and April 1980.

Most of the adults of *M. tuber* were captured in horizontal Malaise traps (D. Focks and Co., P.O. Box 12852, Gainesville, Florida 32608), which were each suspended between 2 trees in either a regrowth forest or an apple orchard from 1977–1982. The collection drums of the Malaise traps were charged with Vapona® or KCN. Between April and October of 1980–1982, one trap was operated in the same location in a regrowth forest and was emptied every two days. The mean number of adults captured per day (for the period from the first to last capture) was calculated for each of the three years.

Voucher specimens of each species of Mecoptera will be deposited in collections at The Connecticut Agricultural Experiment Station, the Illinois Natural History Survey, and the Peabody Museum of Yale University.

Results and Discussion

Description of collecting sites.—Boreids inhabited regrowth forests which had one or more of the mosses upon which they fed. Typically, adults of *B. brumalis* frequented *Dicranella heteromalla* (Hedw.) Schimp. and *Atrichum* spp. moss mats that grew on disturbed soil along woodland paths, at the base of fallen and standing trees, and on eroded hillsides. Adults of *B. nivoriundus* occurred on *Atrichum* spp. that grew in the aforementioned areas and on *Polytrichum ohioense* Ren. and Gord. and *P. commune* Hedw. that developed at the base of large, upright trees and along partially exposed rocky ledges (Maier, unpublished data). Both species of boreids occasionally visited other species of moss or crawled across snow. Dominant overstory trees at major sites were *Quercus alba* L. and *Q. prinus* L. (e.g., Cockaponset St. Forest and West Rock Park, Connecticut) or were *Q. alba* and *Betula* spp. (Ludlow, Vermont). Small stands of *Tsuga canadensis* (L.) Carr. were sometimes intermixed with the deciduous trees. In Edgewood Park, New Haven, Connecticut, *B. brumalis* developed in *D. heteromalla* at the bases of *Fagus grandifolia* Ehrh. and *Q. rubra* L. or under thickets of *Kalmia latifolia* L. near these trees.

The principal collecting site for *M. tuber* was a regrowth forest located at Lockwood Farm in Mount Carmel, Connecticut. This forest (ca. 1 hectare in size) was bordered to the north by an old field, to the east by an apple orchard, to the south

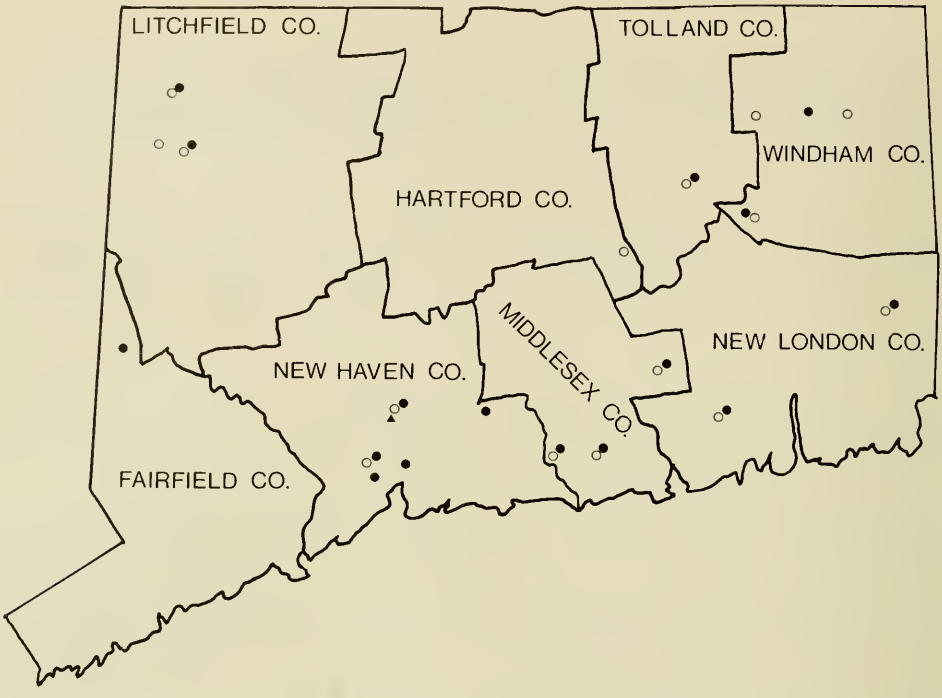

Fig. 1. New distributional records for *Boreus brumalis* (solid circles), *B. nivoriundus* (hollow circles), and *Merope tuber* (solid triangle) collected in Connecticut. More precise distributional data can be obtained from the author.

by a corn field, and to the west by a wet area with trees and shrubs and by a *Pinus resinosa* Ait. plantation. Within 0.5 km of the woodlot was an extensive forest dominated by *Quercus* spp. Characteristic trees at the collecting site were *Acer saccharum* Marsh., *Betula lenta* L., *Fraxinus americana* L., *Q. alba,* and *Q. rubra.* According to records kept since 1950, the woodland has been periodically disturbed. In the 1950's, many of the trees were removed or girdled to facilitate the growth of the *Castanea* spp. in an experimental plot. In the 1960's, shrubby growth was reduced by cutting and use of chemicals. Old stumps in the forest had diameters ranging up to 80 cm.

A Malaise trap was placed in the center of the woodlot in 1979 and between the same two trees in the southwestern corner of the woods from 1980–1982. The southwestern corner was dominated by *A. saccharum* (up to 50 cm in diameter) and by *F. americana* (up to 40 cm in diameter). The elevation at this trapping site was 43 m. The soil had a texture of sandy clay loam and a pH of 5.3 at a depth of 15 cm. The ground sloped about 5 m from the eastern to western edge of the woodlot. An underground rivulet reached the soil surface directly underneath the Malaise trap and flowed into the depression in the adjacent swampy area to the west. The water flow was greatest in winter and spring when a large pool covered about 75% of 0.3-hectare wet area. Several *Q. bicolor* Willd. trees (40–50 cm in diameter) formed a discontinuous canopy in the swampy area. *Cornus* spp., *Lindera benzoin* (L.) Blume, and *Toxicodendron radicans* (L.) Ktze.

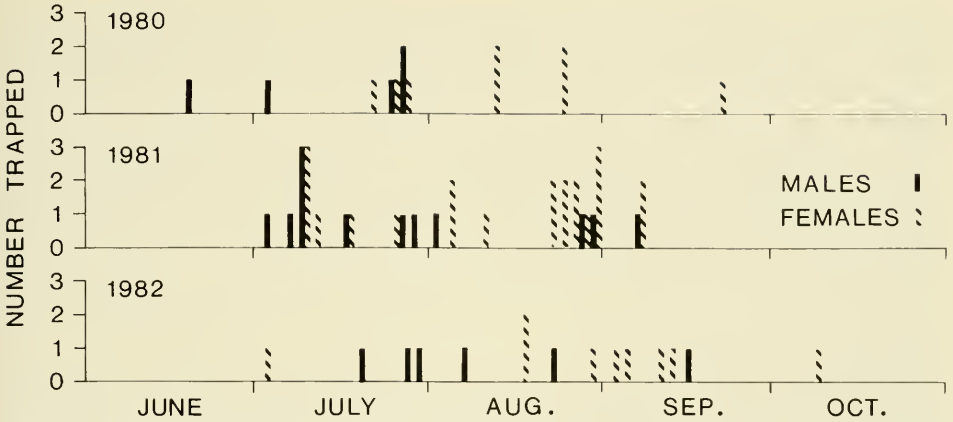

Fig. 2. Seasonal distribution of adults of *Merope tuber*, which were captured between 1980 and 1982 in a horizontal Malaise trap located in a regrowth forest in Mount Carmel, Connecticut.

formed a thicket in the understory. Numerous decaying logs occurred within 100 m of the spot where the rivulet surfaced.

Distributional records.—Each species of *Boreus* was captured at one or more sites in 7 of 8 counties in Connecticut (Fig. 1) and at Ludlow, Windsor Co., Vermont. These collections represented new distributional records that were not included in recent monographs discussing boreids (Penny, 1977; Webb et al., 1975).

The capture of *M. tuber* in New Haven Co. (Fig. 1) provided the second record of this species in Connecticut. Engelhardt (1915) previously collected 3 females at lights in Litchfield Co.

Seasonal activity and abundance.—In Connecticut, the adult activity of *B. brumalis* and *B. nivoriundus* extended from November–April. Webb et al. (1975) and Penny (1977) found that these boreids had a similar period of activity in other areas.

Trapping with sticky plates was a successful new technique for capturing boreid adults. Overall, 77% of the adults of *B. brumalis* (n = 673) and 84% of those of *B. nivoriundus* (n = 839) were collected on sticky traps placed on various mosses. During three consecutive seasons of trapping between November and April, the mean number of adults per trap per day was 0.02 (range 0.01–0.02) for *B. brumalis* and 0.02 (range 0.01–0.03) for *B. nivoriundus*. At four trapping locations used during 1979–1980, the average number captured per trap per day increased from the first sampling period in December–January to the second one in March–April. In the first period, the mean values were 0.03 (range 0.01–0.05) for *B. brumalis* and 0.14 (range 0.04–0.38) for *B. nivoriundus*; in the second period, the means were 0.08 (range 0.04–0.11) and 0.26 (range 0.06–0.57) for these respective species. The increase from winter to spring was correlated with a rise in temperature and, therefore, in adult activity.

Based on samples from a Malaise trap, the flight period of *M. tuber* lasted from June to October (Fig. 2). Although this flight period resembled that reported by Byers (1954), it is the longest recorded from one locale. Captures in the Malaise trap from June–October of 1980–1982 indicated that a disproportionate number

of adults were trapped each month. Monthly captures (represented as % of total caught) were 1.6% in June, 41% in July, 41% in August, 14.8% in September, and 1.6% in October. Caron (1967) made the only other capture in October (one female).

My total catch of *M. tuber* (n = 69) between 1977 and 1982 ranked second to the phenomenal capture of more than 100 adults by Needham (Carpenter, 1932). Annual abundance measured at the same location between 1980 and 1982 varied considerably, being 13 (21.3% of 3-year total) in 1980, 33 (54.1%) in 1981, and 15 (24.6%) in 1982. Over these three years, the average number trapped per day was 0.26 (range 0.15–0.49). Data presented by Scarbrough (1980) also showed a fluctuation in annual abundance of *M. tuber* captured in a Malaise trap.

Sex ratios.—Biased sex ratios characterized the entire collection of each mecopteran species. Males significantly outnumbered females in *B. brumalis* (465 ♂, 208 ♀; $P < 0.001$, chi-square analysis) and in *B. nivoriundus* (608 ♂, 231 ♀; $P < 0.001$). Although males predominated in the whole collection aspirated from moss (51 ♂, 20 ♀ *B. brumalis*; 77 ♂, 30 ♀ *B. nivoriundus*; both P's < 0.001) and trapped on sticky plates on moss (378 ♂, 138 ♀ *B. brumalis*; 518 ♂, 177 ♀ *B. nivoriundus*; both P's < 0.001), females exceeded males in number on the surface of the snow (36 ♂, 50 ♀ *B. brumalis*, $P < 0.25$; 13 ♂, 24 ♀ *B. nivoriundus*, $P < 0.10$). Cooper (1974) found that the sex ratio of pupae of *B. brumalis* and *B. nivoriundus* did not depart significantly from equality. However, Cooper (1974) and Shorthouse (1979) collected more males than females in the field. A review of the sex ratios observed in Boreidae (see Cooper, 1974) showed that males do not consistently outnumber females in collections. Certainly, the sex ratio could be influenced by the collecting technique and time and by the sexual difference in boreid behavior.

For the entire collection of *M. tuber*, females outnumbered males (26 ♂, 43 ♀; $P < 0.05$). Systematic sampling with the Malaise trap between 1980 and 1982 did exhibit a preponderance of females (23 ♂, 38 ♀) although the departure from a 1:1 sex ratio was not significant ($P < 0.10$). Female-biased sex ratios also characterized the collections that Scarbrough (1980) and Sanborne (1982) made with Malaise traps. Comparison of monthly captures from 1980–1982 indicated males dominated in June (1 ♂) and July (15 ♂, 10 ♀) and females dominated in August (5 ♂, 20 ♀), September (2 ♂, 7 ♀), and October (1 ♀).

Acknowledgments

I thank Lewis J. Stannard, Jr. (retired) and Donald W. Webb (Section of Faunistic Surveys and Insect Identification, Illinois Natural History Survey) for introducing me to the study of boreids and meropeids. David Wagner assisted with many of the field collections. Harold Robinson (Department of Botany, National Museum of Natural History, Smithsonian Institution) identified a reference collection of mosses. Richard Jaynes (Department of Forestry and Horticulture, The Connecticut Agricultural Experiment Station) provided valuable details about the principal collecting site for *M. tuber*.

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